

We claim:

1. A polymerizable organic composition comprising one or more radically polymerizable monomers, at least one of which is a first monomer having at least two (meth)acryloyl groups and comprising one or more backbone linkages selected from the group consisting of thiourethane linkages and dithiourethane linkages.

2. The polymerizable organic composition of claim 1 further comprising at least one monomer selected from the group consisting of:

(a) a second radically polymerizable monomer that is different than said first monomer and having at least two ethylenically unsaturated radically polymerizable groups selected from vinyl, allyl and (meth)acryloyl;

(b) a third radically polymerizable monomer having at least one ethylenically unsaturated radically polymerizable group, which is different than said first monomer and said second monomer, selected from the group consisting of, (i) a monoethylenically unsaturated monomer and (ii) an anhydride monomer having at least one ethylenically unsaturated group, which is different than monomer (i); and

(c) a polythiol monomer having at least two thiol groups.

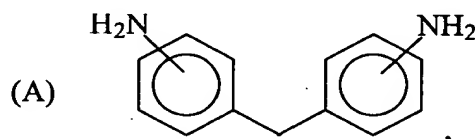
3. The polymerizable composition of claim 1 wherein a precursor of said first monomer is prepared from the reaction of a reactive hydrogen material, which is a polythiol monomer having at least two thiol groups, and a polycyanate monomer having at least two functional groups selected from at least one of the group consisting of isocyanate and isothiocyanate.

4. The polymerizable composition of claim 3 wherein the precursor of said first monomer having terminal reactive hydrogen groups is functionalized by reacting with one or more selected from the group consisting of (meth)acrylic anhydride, (meth)acrylyl chloride, glycidyl (meth)acrylate, isocyanato alkyl (meth)acrylate, hydroxy alkyl (meth)acrylate chloroformate esters and hydroxyethylmethacrylate chloroformate ester.

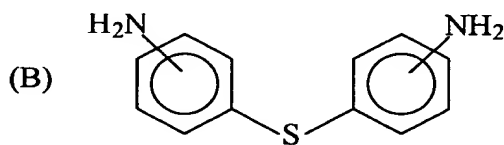
5. The polymerizable composition of claim 3 wherein the molar equivalent ratio of (NCO + NCS)/(SH) is from 0.25 : 1 to 4 : 1.

6. The polymerizable composition of claim 3 wherein the reactive hydrogen material further comprises at least two reactive hydrogen groups selected from the group consisting of hydroxyl, primary amine, secondary amine and compounds having one or more thiol and one or more hydroxyl groups.

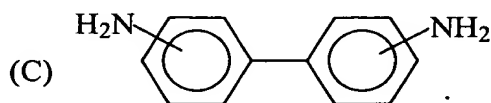
7. The polymerizable composition of claim 6 wherein the reactive hydrogen material is a polyamine selected from the group consisting of ethyleneamines, C₁-C₃ dialkyl toluenediamine, methylene dianiline, trimethyleneglycol di(para-aminobenzoate), a diamine represented by the general formula (A):



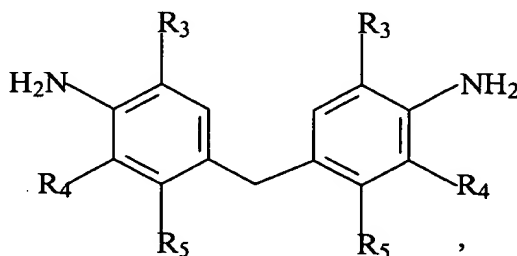
a diamine represented by the general formula (B):

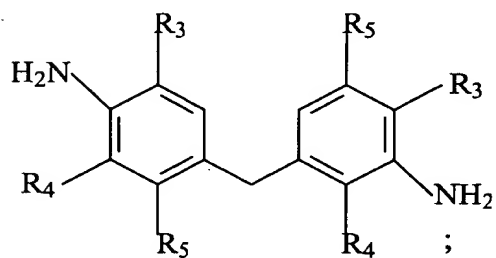
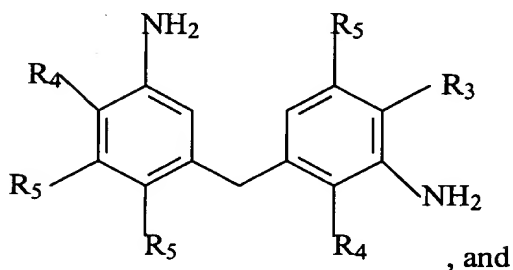
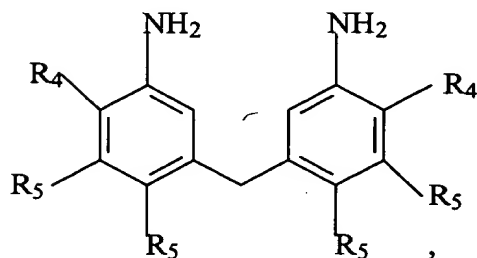
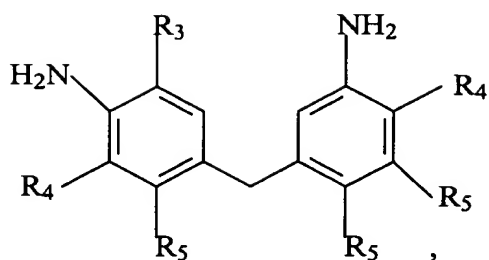


and a diamine represented by the general formula (C):



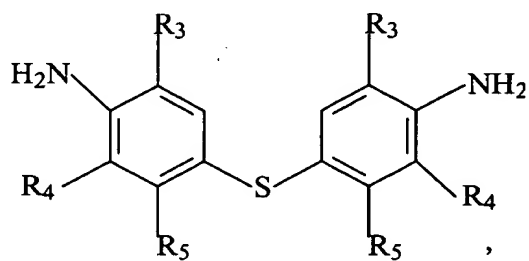
8. The polymerizable composition of claim 7 wherein the diamine of general formula (A) is selected from one or more of the group consisting of:

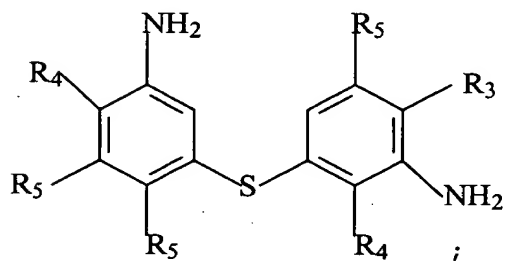
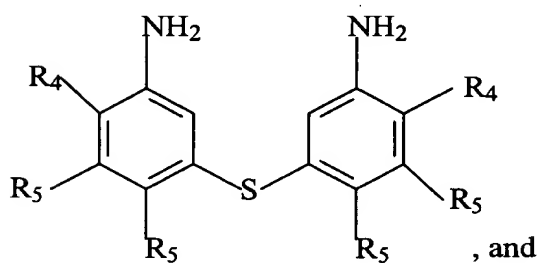
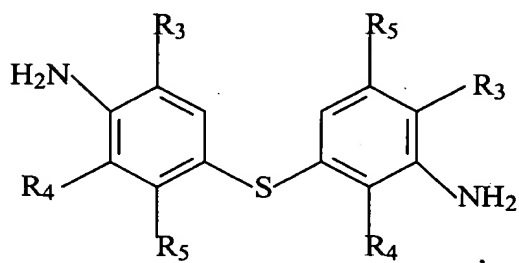
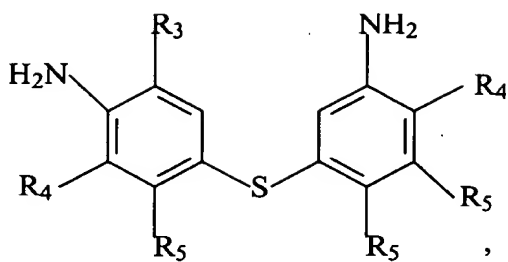




wherein R_3 and R_4 are each independently C_1 - C_3 alkyl, and R_5 is selected from hydrogen and halogen, and mixtures of said diamines.

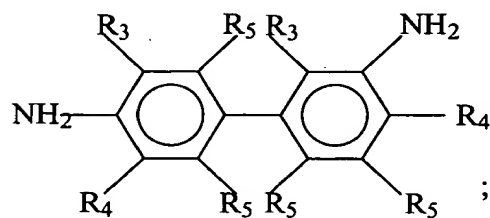
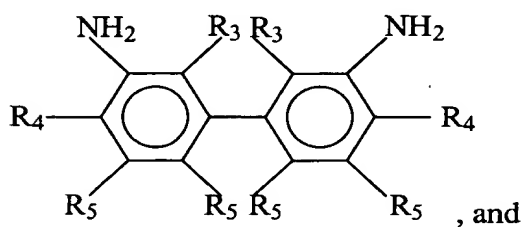
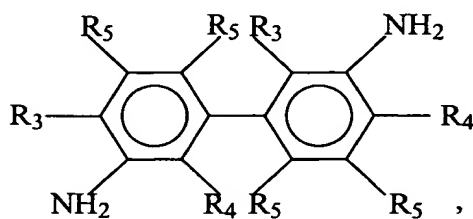
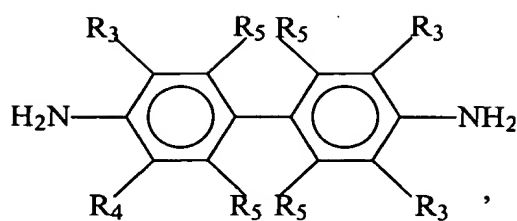
- 5 9. The polymerizable composition of claim 7 wherein the diamine of general formula (B) is selected from one or more of the group consisting of:





wherein R_3 and R_4 are each independently C_1 - C_3 alkyl, and R_5 is selected from hydrogen and halogen, and mixtures of said diamines.

- 5 10. The polymerizable composition of claim 7 wherein the diamine of general formula (C) is selected from one or more of the group consisting of:



wherein R_3 and R_4 are each independently C_1 - C_3 alkyl, and R_5 is selected from hydrogen and halogen, and mixtures of said diamines.

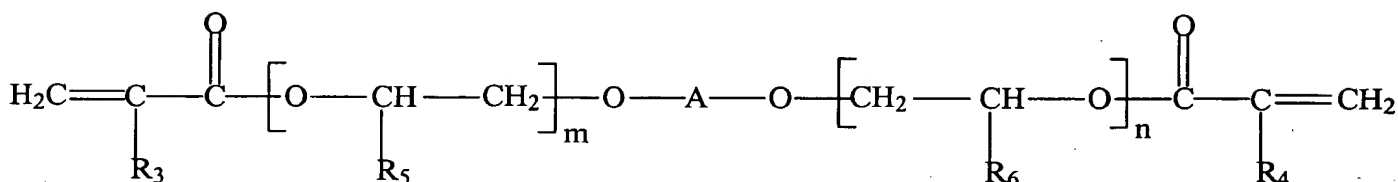
- 5 11. The polymerizable composition of claim 6 wherein the molar equivalent ratio of $(NCO + NCS)/(SH + OH + NH_2 + -NH-)$ is from 0.25 : 1 to 4 : 1.

- 10 12. The polymerizable composition of claim 6 wherein the thiol groups of said polythiol monomer comprise at least 50 mole percent, based on the total molar equivalents of thiol groups, hydroxyl groups, primary amine groups and secondary amine groups of said polythiol monomer and said reactive hydrogen material.

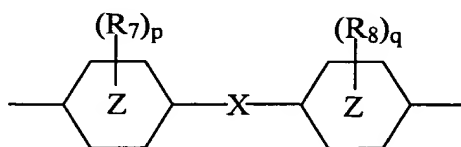
13. The polymerizable composition of claim 2 wherein said second monomer is an aromatic monomer having at least two vinyl groups and is selected from the group consisting of divinyl benzene, diisopropenyl benzene, trivinyl benzene, divinyl naphthalene, halogen substituted derivatives of divinyl benzene, diisopropenyl benzene, trivinyl benzene, divinyl naphthalene and mixtures thereof.

14. The polymerizable composition of claim 2 wherein said second monomer has (meth)acryloyl groups and is selected from one or more of the group consisting of:

(i) a monomer represented by the following general formula:




wherein m and n are each a positive number, the sum of m and n being from 0 to 70, R₃ and R₄ are each hydrogen or methyl, R₅ and R₆ are each hydrogen or C₁ to C₂ alkyl, and A is a divalent linking group selected from the group consisting of straight or branched chain alkylene, cyclic alkylene, phenylene, C₁ - C₉ alkyl substituted phenylene, and a group represented by the following general formula:

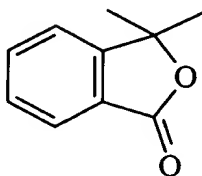


wherein, R₇ and R₈ are each C₁ - C₄ alkyl, chlorine or bromine, p and q are each an

integer from 0 to 4,  represents either a divalent benzene group or a

divalent cyclohexane group, when  represents a divalent benzene group, X

is selected from the group consisting of O, S, $-S(O_2)-$, $-C(O)-$, $-CH_2-$, $-CH=CH-$, $-C(CH_3)_2-$,



$-C(CH_3)(C_6H_5)-$ and

; when



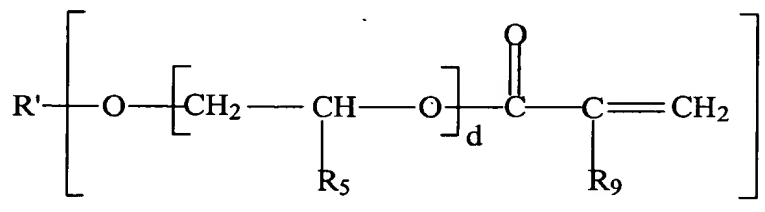
represents a divalent

cyclohexane group, X is selected from the group consisting of O, S, $-CH_2-$, and

5 $-C(CH_3)_2-$;

(ii) a bis[(meth)acryloyl-terminated]poly(ethylene glycol) monomer, that is different than monomer (i), having a number average molecular weight from 200 to 2,000 grams / mole; and

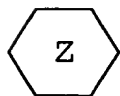
(iii) a poly(meth)acryloyl terminated monomer represented by the
10 following general formula:



wherein R' is a polyvalent radical of a polyol, R_9 is hydrogen or methyl, R_5 is hydrogen or C_1 to C_2 alkyl, d is a number from 0 to 20, and j is a whole number from 3 to 6.

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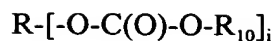
15. The polymerizable composition of claim 14 wherein X is $-C(CH_3)_2-$,



represents a divalent benzene group, p and q are each 0, R_3 and R_4 are each methyl, R_5 and R_6 are each hydrogen, the sum of m and n is from 5 to 20, R' is a radical of pentaerythritol, j is 3, R_9 is hydrogen and d is 0.

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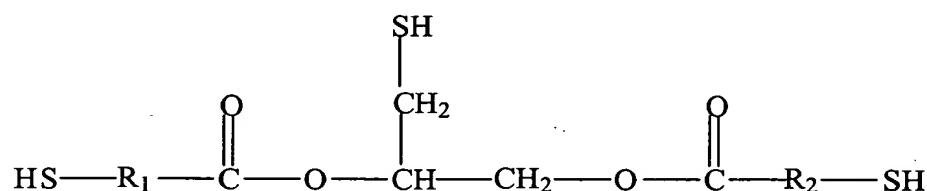
16. The polymerizable composition of claim 2 wherein said second monomer has allyl groups and is represented by the following general formula,



wherein R is a radical derived from a polyol, R_{10} is a radical derived from an allyl or substituted allyl group and i is a whole number from 2 to 6.

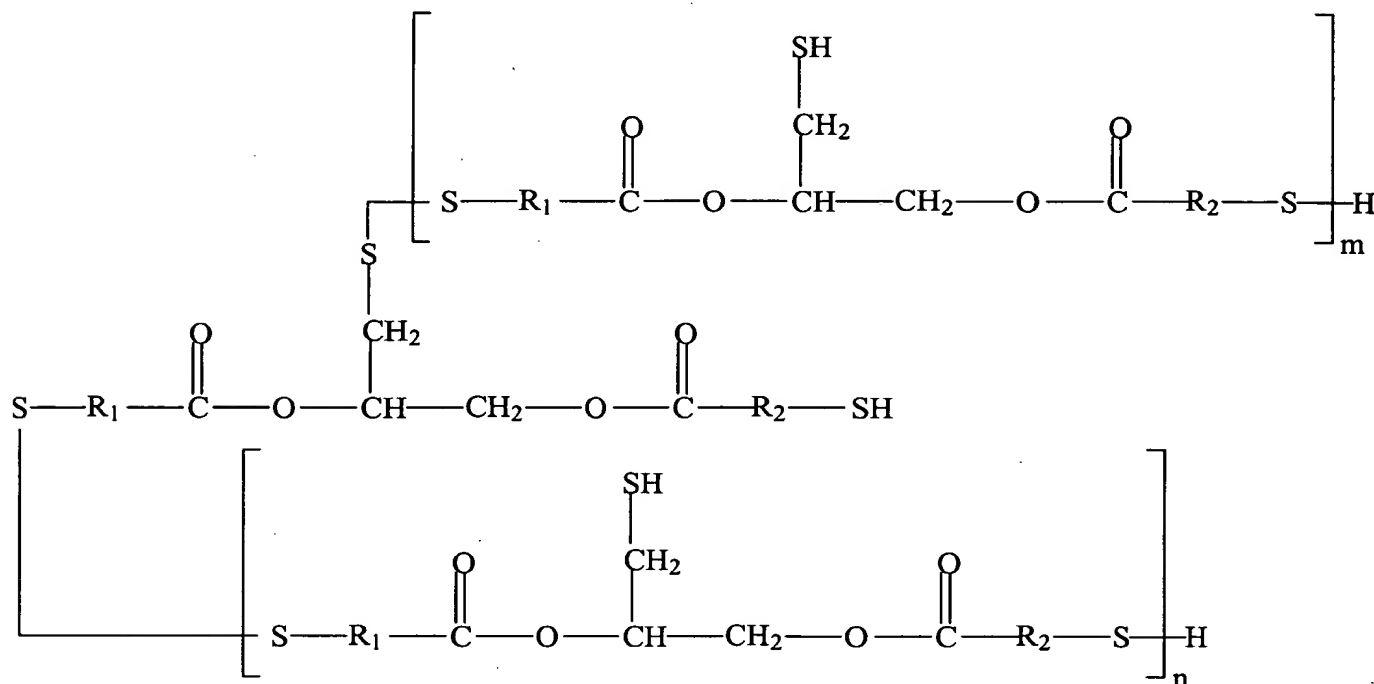
- 5 17. The polymerizable composition of claim 16 wherein the polyol from which R is derived is 4,4'-isopropylidenediphenol, i is 2, and R_{10} is a radical derived from an allyl group.

- 10 18. The polymerizable composition of claim 2 wherein said polythiol monomer is one or more selected from the group consisting of 2,5-dimercaptomethyl-1,4-dithiane, 2,2'-thiodiethanethiol, pentaerythritol tetrakis(3-mercaptopropionate), pentaerythritol tetrakis(2-mercaptopropionate), trimethylolpropane tris(3-mercaptopropionate), trimethylolpropane tris(2-mercaptopropionate), 4-mercaptomethyl-3,6-dithia-1,8-octanedithiol, 4-tert-butyl-1,2-benzenedithiol, 4,4'-thiodibenzenethiol, 15 benzenedithiol, ethylene glycol di(2-mercaptopropionate), ethylene glycol di(3-mercaptopropionate), poly(ethylene glycol) di(2-mercaptopropionate), poly(ethylene glycol) di(3-mercaptopropionate), a polythiol represented by the following general formula:



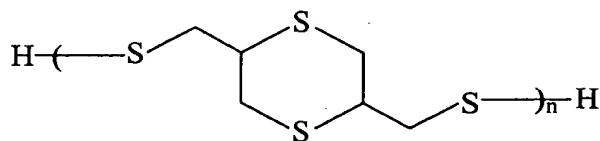
- 20 in which R_1 and R_2 are each independently selected from the group consisting of straight or branched chain alkylene, cyclic alkylene, phenylene and $C_1 - C_9$ alkyl substituted phenylene, and oligomers of said polythiols.

19. The method of claim 18 wherein said polythiol oligomer is represented by the general formula:



wherein R_1 and R_2 are each independently selected from straight or branched chain alkylene, cyclic alkylene, phenylene and C_1 - C_9 alkyl substituted phenylene and n and m are independently integers from 0 to 21 such that $n + m$ is at least 1.

20. The polymerizable organic composition of claim 18 wherein said polythiol oligomer is represented by the general formula:



wherein n is an integer from 1 to 21.

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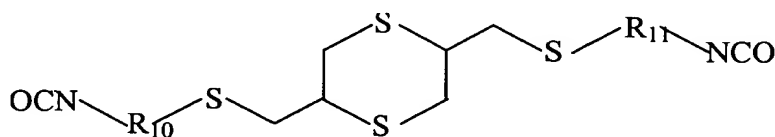
21. The polymerizable organic composition of claim 2 wherein said monoethylenically unsaturated monomer is one or more selected from the group consisting of styrene, methyl methacrylate, isobornyl methacrylate, phenoxyethyl

methacrylate, cyclohexyl methacrylate, vinyl acetate, vinyl chloride, mercaptoethyl (meth)acrylate, vinyl mercaptan and allyl mercaptan.

22. The polymerizable composition of claim 2 wherein said anhydride
5 monomer is selected from the group consisting of methacrylic anhydride, acrylic anhydride, maleic anhydride, 1-cyclopentene-1,2-dicarboxylic anhydride, itaconic anhydride and mixtures of said monomers.

23. The polymerizable organic composition of claim 3 wherein the
10 polycyanate monomer having at least two functional groups has one or more sulfur atoms in its backbone.

24. The polymerizable organic composition of claim 23 wherein the
15 polycyanate monomer containing one or more sulfur atoms in its backbone has the general structure:



wherein R_{10} and R_{11} are each independently C_1 to C_3 alkyl.

25. A polymerizate formed by polymerizing a polymerizable organic
composition comprising one or more radically polymerizable monomers, at least one
20 of which is a first monomer having at least two (meth)acryloyl groups and comprising one or more backbone linkages selected from the group consisting of thiourethane linkages and dithiourethane linkages.

26. The polymerizate of claim 25 further comprising at least one monomer
25 selected from the group consisting of:

(a) a second radically polymerizable monomer that is different than said first monomer and having at least two ethylenically unsaturated radically polymerizable groups selected from vinyl, allyl and (meth)acryloyl;

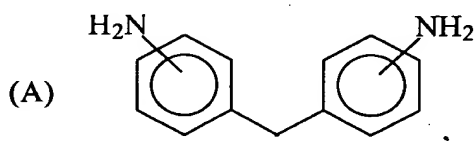
- (b) a third radically polymerizable monomer having at least one ethylenically unsaturated radically polymerizable group, which is different than said first monomer and said second monomer, selected from the group consisting of, (i) a monoethylenically unsaturated monomer and (ii) an anhydride monomer having at least one ethylenically unsaturated group, which is different than monomer (i); and
- (c) a polythiol monomer having at least two thiol groups.

27. The polymerizate of claim 25 wherein a precursor of said first monomer is prepared from the reaction of a reactive hydrogen material, which is a polythiol monomer having at least two thiol groups, and a polycyanate monomer having at least two functional groups selected from at least one of the group consisting of isocyanate and isothiocyanate.

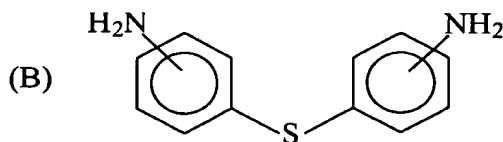
28. The polymerizate of claim 257 wherein the molar equivalent ratio of $(\text{NCO} + \text{NCS})/(\text{SH})$ is from 0.25 : 1 to 4 : 1.

29. The polymerizate of claim 27 wherein the reactive hydrogen material further comprises at least two reactive hydrogen groups selected from the group consisting of hydroxyl, primary amine, secondary amine, and compounds having one or more thiol and one or more hydroxyl groups.

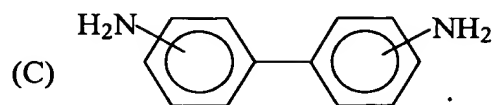
30. The polymerizate of claim 29 wherein the reactive hydrogen material is a polyamine selected from the group consisting of ethyleneamines, $\text{C}_1\text{-C}_3$ dialkyl toluediamine, methylene dianiline, trimethyleneglycol di(para-aminobenzoate), a diamine represented by the general formula (A):



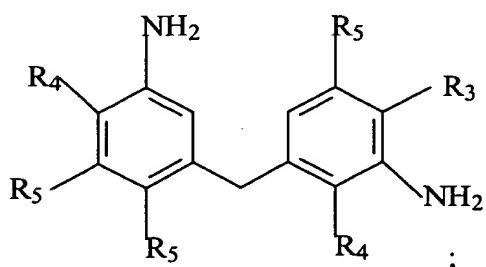
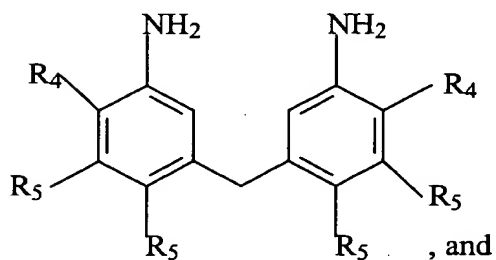
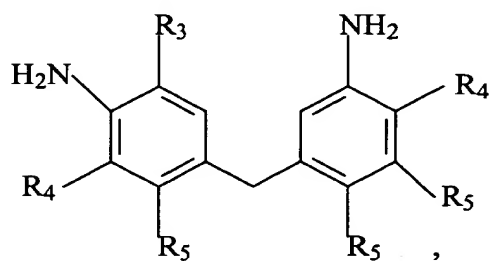
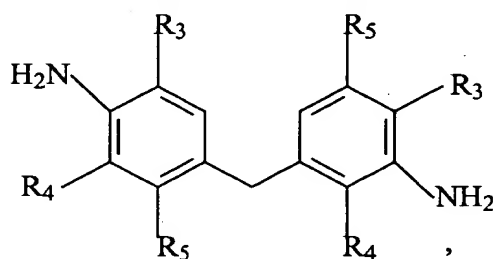
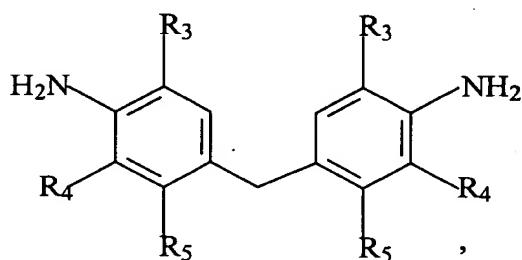
a diamine represented by the general formula (B):



and a diamine represented by the general formula (C):

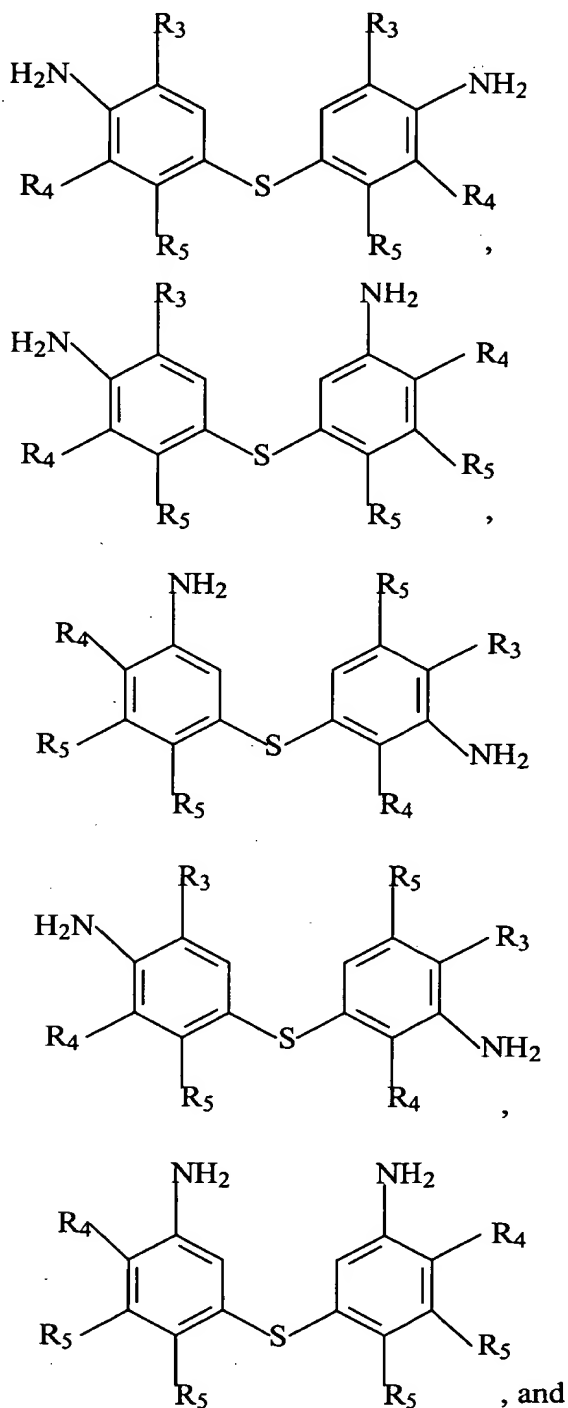


31. The polymerizate of claim 30 wherein the diamine of general formula (A) is selected from one or more of the group consisting of:



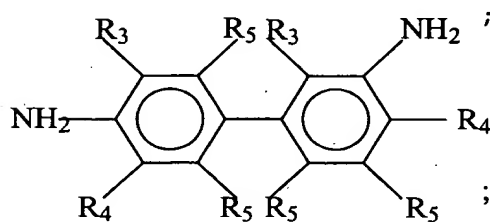
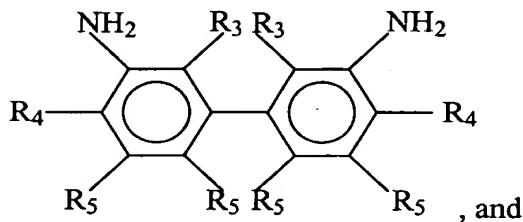
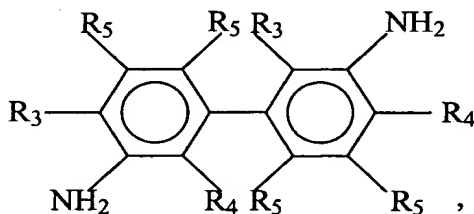
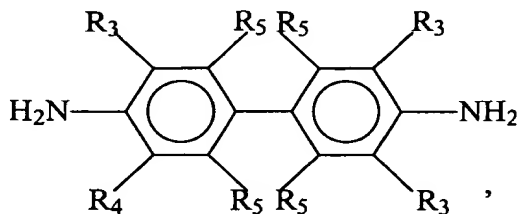
wherein R_3 and R_4 are each independently C_1 - C_3 alkyl, and R_5 is selected from hydrogen and halogen, and mixtures of said diamines.

32. The polymerizable composition of claim 30 wherein the diamine of
5 general formula (B) is selected from one or more of the group consisting of:



wherein R_3 and R_4 are each independently C_1 - C_3 alkyl, and R_5 is selected from hydrogen and halogen, and mixtures of said diamines.

33. The polymerizate of claim 30 wherein the diamine of general formula (C) is selected from one or more of the group consisting of:



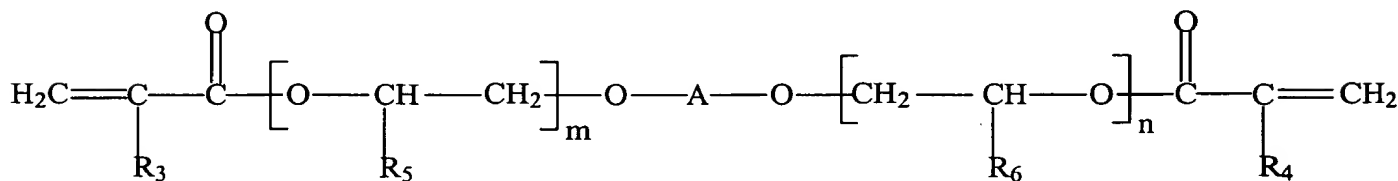
wherein R_3 and R_4 are each independently C_1 - C_3 alkyl, and R_5 is selected from hydrogen and halogen, and mixtures of said diamines.

34. The polymerizate of claim 29 wherein the molar equivalent ratio of (NCO + NCS)/(SH + OH + NH₂ + -NH-) is from 0.25 : 1 to 4 : 1.

35. The polymerizate of claim 29 wherein the thiol groups of said polythiol monomer comprise at least 50 mole percent, based on the total molar equivalents of thiol groups, hydroxyl groups, primary amine groups and secondary amine groups of said polythiol monomer and said reactive hydrogen material.

36. The polymerizate of claim 26 wherein said second monomer is an aromatic monomer having at least two vinyl groups and is selected from the group consisting of divinyl benzene, diisopropenyl benzene, trivinyl benzene, divinyl naphthalene, halogen substituted derivatives of divinyl benzene, diisopropenyl benzene, trivinyl benzene, divinyl naphthalene and mixtures thereof.

37. The polymerizate of claim 26 wherein said second monomer has

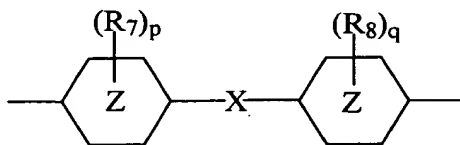


(meth)acryloyl groups and is selected from one or more of the group consisting of:

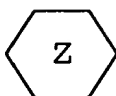
(i) a monomer represented by the following general formula:


wherein m and n are each a positive number, the sum of m and n being from 0 to 70,

R₃ and R₄ are each hydrogen or methyl, R₅ and R₆ are each hydrogen or C₁ to C₂ alkyl, and A is a divalent linking group selected from the group consisting of straight or branched chain alkylene, cyclic alkylene, phenylene, C₁ - C₉ alkyl substituted phenylene, and a group represented by the following general formula:

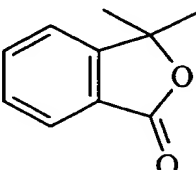



wherein, R_7 and R_8 are each $C_1 - C_4$ alkyl, chlorine or bromine, p and q are each an

integer from 0 to 4,  represents either a divalent benzene group or a

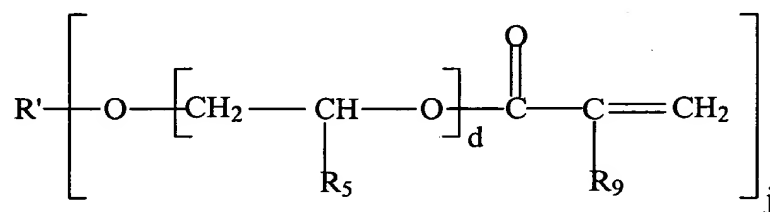
divalent cyclohexane group, when  represents a divalent benzene group, X is selected from the group consisting of O, S, $-S(O_2)-$, $-C(O)-$, $-CH_2-$, $-CH=CH-$,

5 $-C(CH_3)_2-$,

 ; when  represents a divalent cyclohexane group, X is selected from the group consisting of O, S, $-CH_2-$, and $-C(CH_3)_2$;

(ii) a bis[(meth)acryloyl-terminated]poly(ethylene glycol) monomer, that is different than monomer (i), having a number average molecular weight from 200 to 2,000 grams / mole; and

(iii) a poly(meth)acryloyl terminated monomer represented by the following general formula:



15 wherein R' is a polyvalent radical of a polyol, R_9 is hydrogen or methyl, R_5 is hydrogen or C_1 to C_2 alkyl, d is a number from 0 to 20, and j is a whole number from 3 to 6.



38. The polymerizate of claim 37 wherein X is $-\text{C}(\text{CH}_3)_2-$, represents a divalent benzene group, p and q are each 0, R₃ and R₄ are each methyl, R₅ and R₆ are each hydrogen, the sum of m and n is from 5 to 20, R' is a radical of pentaerythritol, j is 3, R₉ is hydrogen and d is 0.

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39. The polymerizate of claim 26 wherein said second monomer has allyl groups and is represented by the following general formula:



wherein R is a radical derived from a polyol, R₁₀ is a radical derived from an allyl or substituted allyl group and i is a whole number from 2 to 6.

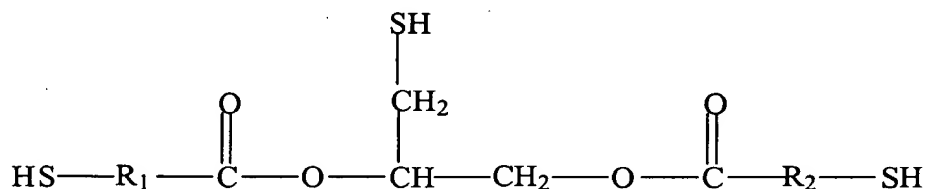
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40. The polymerizate of claim 39 wherein the polyol from which R is derived is 4,4'-isopropylidenediphenol, i is 2, and R₁₀ is a radical derived from an allyl group.

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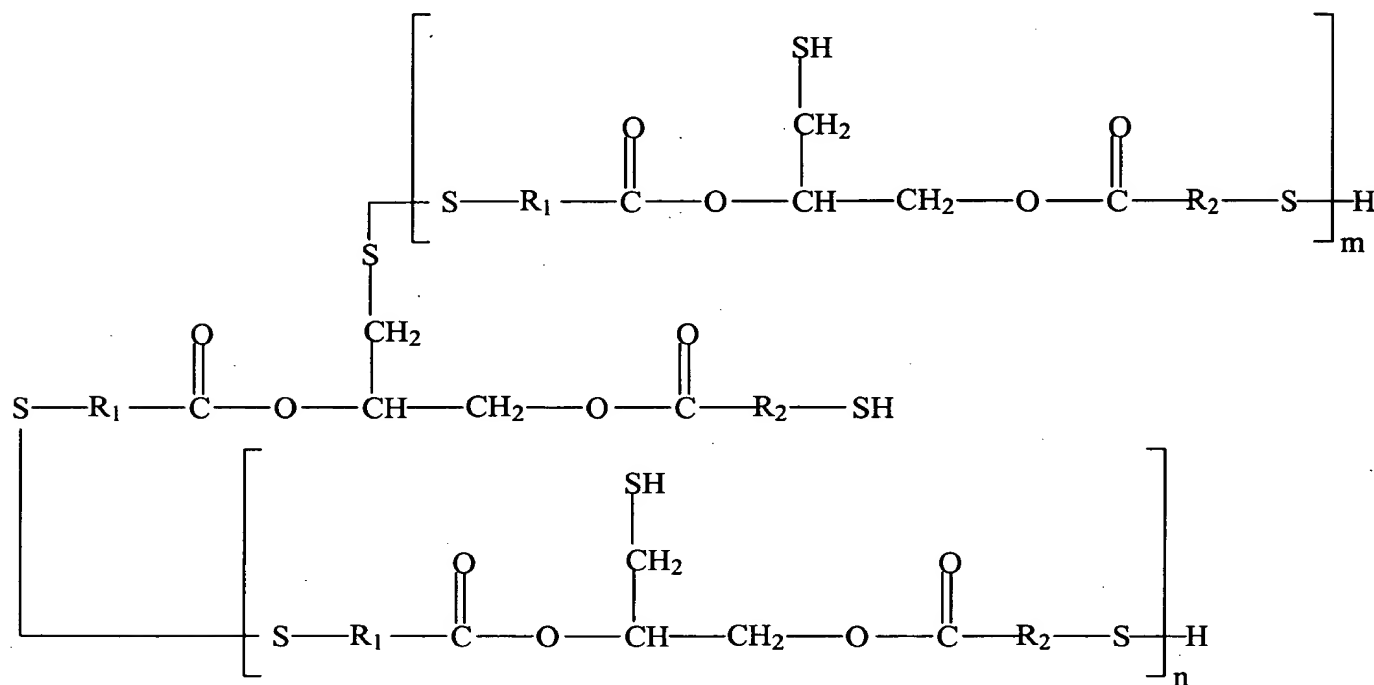
41. The polymerizate of claim 26 wherein said polythiol monomer is one or more selected from the group consisting of 2,5-dimercaptomethyl-1,4-dithiane, 2,2'-thiodiethanethiol, pentaerythritol tetrakis(3-mercaptopropionate), pentaerythritol tetrakis(2-mercptoacetate), trimethylolpropane tris(3-mercaptopropionate), trimethylolpropane tris(2-mercptoacetate), 4-mercaptopomethyl-3,6-dithia-1,8-octanedithiol, 4-tert-butyl-1,2-benzenedithiol, 4,4'-thiodibenzenethiol, benzenedithiol, ethylene glycol di(2-mercptoacetate), ethylene glycol di(3-mercaptopropionate), poly(ethylene glycol) di(2-mercptoacetate), poly(ethylene glycol) di(3-mercaptopropionate), a polythiol represented by the following general formula:

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in which R_1 and R_2 are each independently selected from the group consisting of straight or branched chain alkylene, cyclic alkylene, phenylene and $C_1 - C_9$ alkyl substituted phenylene, and oligomers of said polythiols.

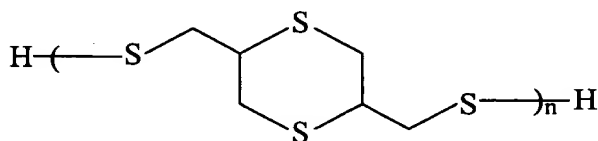
- 5 42. The polymerizate of claim 41 wherein said polythiol oligomer is represented by the general formula:



wherein R_1 and R_2 are each independently selected from straight or branched chain alkylene, cyclic alkylene, phenylene and $C_1 - C_9$ alkyl substituted phenylene and n and m are independently integers from 0 to 21 such that $n + m$ is at least 1.

10

43. The polymerizate of claim 41 wherein said polythiol oligomer is represented by the general formula:



wherein n is an integer from 1 to 21.

44. The polymerizate composition of claim 26 wherein said monoethylenically unsaturated monomer is one or more selected from the group consisting of styrene, methyl methacrylate, isobornyl methacrylate, phenoxyethyl methacrylate, cyclohexyl methacrylate, vinyl acetate, vinyl chloride, mercaptoethyl (meth)acrylate, vinyl mercaptan and allyl mercaptan.

45. The polymerizate of claim 26 wherein said anhydride monomer is selected from the group consisting of methacrylic anhydride, acrylic anhydride, maleic anhydride, 1-cyclopentene-1,2-dicarboxylic anhydride, itaconic anhydride and mixtures of said monomers.

46. The polymerizate of claim 25 having an initial Barcol hardness of at least 1, a refractive index of from about 1.57 to about 1.80 and an Abbe number of at least about 30.

47. The polymerizate of claim 25 further comprising one or more additives selected from the group consisting of light stabilizers, heat stabilizers, antioxidants, ultraviolet light absorbers, mold release agents, static (non-photochromic) dyes, pigments and flexibilizing additives and anti-yellowing additives.

48. The polymerizate of claim 47 wherein the additives are present in an amount up to 10% by weight of said polymerizate.

49. The polymerizate of claim 25 further comprising a photochromic substance.

50. The polymerizate of claim 25 wherein polymerization of the polymerizable organic composition is accomplished by adding to the composition an initiating amount of a material capable of generating free radicals.

51. The polymerizate of claim 50 wherein the material capable of generating free radicals is selected from the group consisting of organic peroxy compounds, azobis(organonitrile) compounds and photopolymerization initiators.

5 52. The polymerizate of claim 51 wherein the organic peroxy compounds are selected from the group consisting of tertiarybutylperoxy 2-ethylhexyl carbonate, tertiarybutylperoxy isopropyl carbonate, 1,1-di-(t-butyl peroxy)-3,3,5-trimethylcyclohexane, di(2-ethylhexyl) peroxydicarbonate, di(secondary butyl) peroxydicarbonate, diisopropylperoxydicarbonate, 2,4-dichlorobenzoyl peroxide, 10 isobutyryl peroxide, decanoyl peroxide, lauroyl peroxide, propionyl peroxide, acetyl peroxide, benzoyl peroxide, p-chlorobenzoyl peroxide, t-butylperoxy pivalate, t-butylperoxy octylate, t-butylperoxyisobutyrate, methylethylketone peroxide and acetylcyclohexane sulfonyl peroxide.

15 53. The polymerizate of claim 51 wherein the azobis(organonitrile) compounds are selected from the group consisting of azobis(isobutyronitrile) and azobis(2,4-dimethylvaleronitrile).

20 54. The polymerizate of claim 51 wherein the photopolymerization initiators are selected from the group consisting of benzoin, benzoin methyl ether, benzoin isobutyl ether, benzophenone, acetophenone, 4,4'-dichlorobenzophenone, diethoxyacetophenone, 2-hydroxy-2-methyl-1-phenylpropan-1-one, 1-hydroxycyclohexyl phenyl ketone, 2-isopropylthioxanthone and 2,4,6-trimethylbenzoyldiphenylphosphine oxide.

25 55. A shaped article formed by polymerizing the polymerizable organic composition of claim 1.

30 56. A photochromic article formed by polymerizing a polymerizable organic composition comprising one or more radically polymerizable monomers, at least one of which is a first monomer having at least two (meth)acryloyl groups and comprising

one or more backbone linkages selected from the group consisting of thiourethane linkages and dithiourethane linkages.

57. The photochromic article of claim 56 further comprising at least one
5 monomer selected from the group consisting of:

(a) a second radically polymerizable monomer that is different than said first monomer and having at least two ethylenically unsaturated radically polymerizable groups selected from vinyl, allyl and (meth)acryloyl;

(b) a third radically polymerizable monomer having at least one
10 ethylenically unsaturated radically polymerizable group, which is different than said first monomer and said second monomer, selected from the group consisting of, (i) a monoethylenically unsaturated monomer and (ii) an anhydride monomer having at least one ethylenically unsaturated group, which is different than monomer (i); and
(c) a polythiol monomer having at least two thiol groups.

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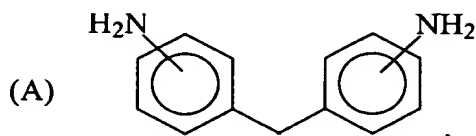
58. The photochromic article of claim 56 wherein a precursor of said first monomer is prepared from the reaction of a reactive hydrogen material, which is a polythiol monomer having at least two thiol groups, and a polycyanate monomer having at least two functional groups selected from at least one of the group
20 consisting of isocyanate and isothiocyanate.

59. The photochromic article of claim 58 wherein the molar equivalent ratio of $(\text{NCO} + \text{NCS})/(\text{SH})$ is from 0.25 : 1 to 4 : 1.

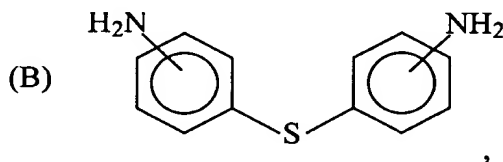
25 60. The photochromic article of claim 58 wherein the reactive hydrogen material further comprises at least two reactive hydrogen groups selected from the group consisting of hydroxyl, primary amine, secondary amine and compounds having one or more thiol and one or more hydroxyl groups.

30 61. The photochromic article of claim 60 wherein the reactive hydrogen material is a polyamine selected from the group consisting of ethyleneamines, $\text{C}_1\text{-C}_3$

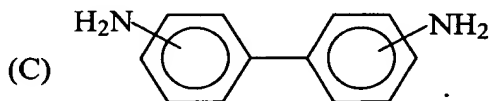
dialkyl toluediamine, methylene dianiline, trimethyleneglycol di(para-aminobenzoate), a diamine represented by the general formula (A):



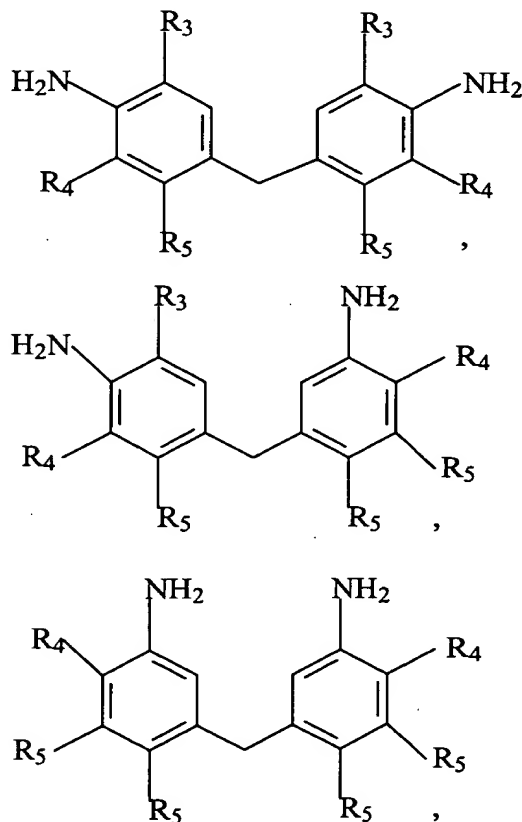
5 a diamine represented by the general formula (B):

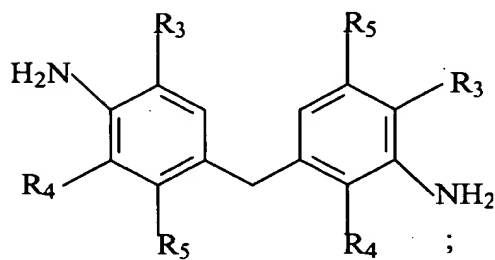
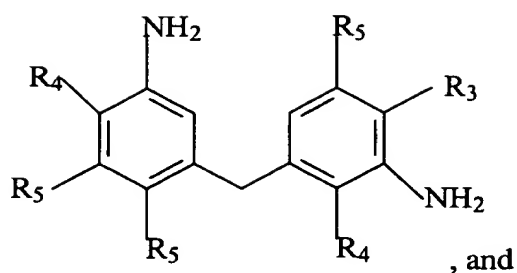


and a diamine represented by the general formula (C):



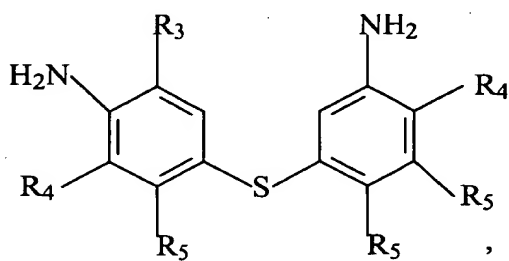
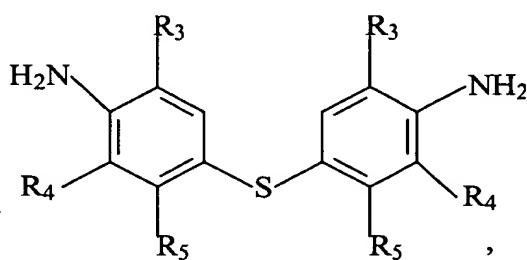
62. The polymerizable composition of claim 61 wherein the diamine of general formula (A) is selected from one or more of the group consisting of:

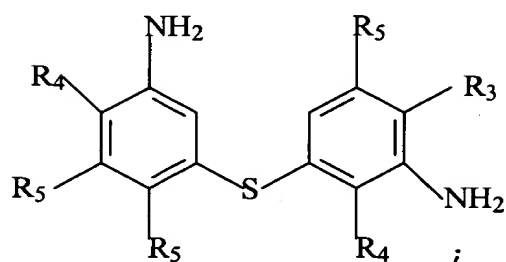
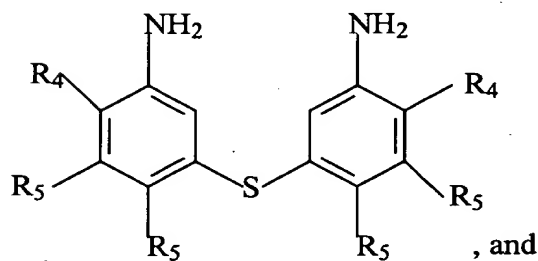
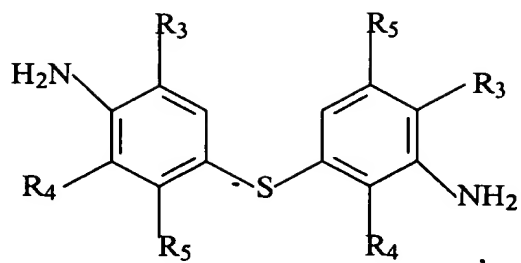




wherein R_3 and R_4 are each independently C_1 - C_3 alkyl, and R_5 is selected from hydrogen and halogen, and mixtures of said diamines.

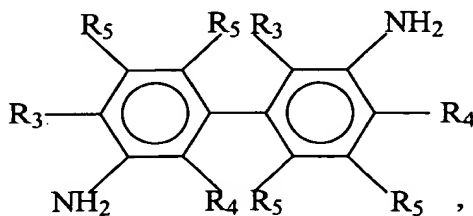
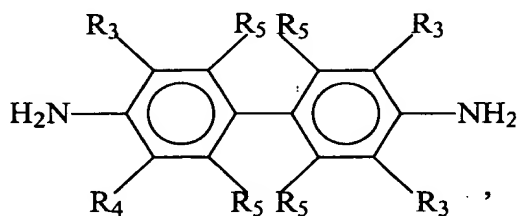
- 5 63. The photochromic article of claim 61 wherein the diamine of general formula (B) is selected from one or more of the group consisting of:

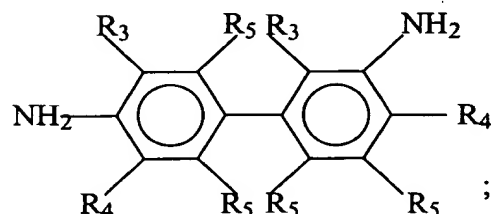
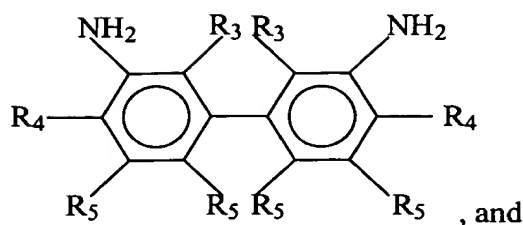




wherein R_3 and R_4 are each independently C_1 - C_3 alkyl, and R_5 is selected from hydrogen and halogen, and mixtures of said diamines.

- 5 64. The polymerizable composition of claim 61 wherein the diamine of general formula (C) is selected from one or more of the group consisting of:





wherein R_3 and R_4 are each independently C_1 - C_3 alkyl, and R_5 is selected from hydrogen and halogen, and mixtures of said diamines.

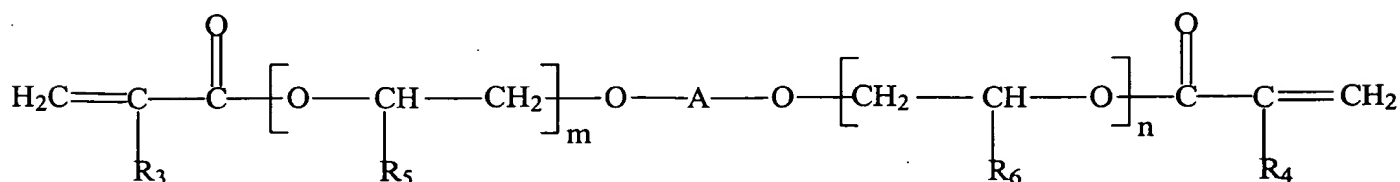
65. The photochromic article of claim 60 wherein the molar equivalent ratio of $(NCO + NCS)/(SH + OH + NH_2 + -NH-)$ is from 0.25 : 1 to 4 : 1.

66. The photochromic article of claim 60 wherein the thiol groups of said polythiol monomer comprise at least 50 mole percent, based on the total molar equivalents of thiol groups, hydroxyl groups, primary amine groups and secondary amine groups of said polythiol monomer and said reactive hydrogen material.

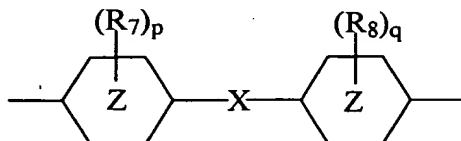
67. The photochromic article of claim 57 wherein said second monomer is an aromatic monomer having at least two vinyl groups and is selected from the group consisting of divinyl benzene, diisopropenyl benzene, trivinyl benzene, divinyl naphthalene, halogen substituted derivatives of divinyl benzene, diisopropenyl benzene, trivinyl benzene, divinyl naphthalene and mixtures thereof.

68. The photochromic article of claim 57 wherein said second monomer has (meth)acryloyl groups and is selected from one or more of the group consisting of:

(i) a monomer represented by the following general formula:




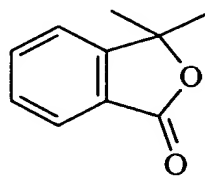
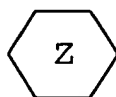
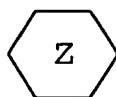
- wherein m and n are each a positive number, the sum of m and n being from 0 to 70, R₃ and R₄ are each hydrogen or methyl, R₅ and R₆ are each hydrogen or C₁ to C₂ alkyl, and A is a divalent linking group selected from the group consisting of straight or branched chain alkylene, cyclic alkylene, phenylene, C₁ - C₉ alkyl substituted phenylene, and a group represented by the following general formula:



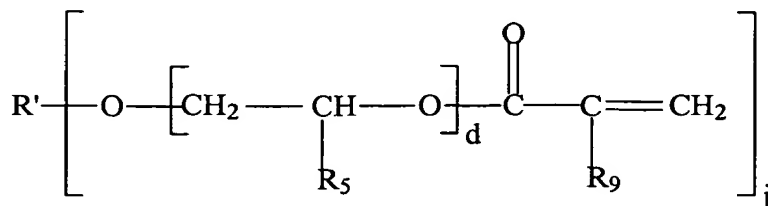
wherein, R₇ and R₈ are each C₁ - C₄ alkyl, chlorine or bromine, p and q are each an

integer from 0 to 4,  represents either a divalent benzene group or a

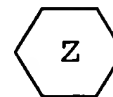
- divalent cyclohexane group, when  represents a divalent benzene group, X is selected from the group consisting of O, S, -S(O₂)-, -C(O)-, -CH₂-, -CH=CH-, -C(CH₃)₂-,

 and ; when  represents a divalent cyclohexane group, X is selected from the group consisting of O, S, -CH₂-, and -C(CH₃)₂;

- (ii) a bis[(meth)acryloyl-terminated]poly(ethylene glycol) monomer, that is different than monomer (i), having a number average molecular weight from 200 to 2,000 grams / mole; and
- (iii) a poly(meth)acryloyl terminated monomer represented by the following general formula:

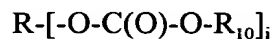


wherein R' is a polyvalent radical of a polyol, R₉ is hydrogen or methyl, R₅ is hydrogen or C₁ to C₂ alkyl, d is a number from 0 to 20, and j is a whole number from 3 to 6.



5 69. The photochromic article of claim 68 wherein X is -C(CH₃)₂-, represents a divalent benzene group, p and q are each 0, R₃ and R₄ are each methyl, R₅ and R₆ are each hydrogen, the sum of m and n is from 5 to 20, R' is a radical of pentaerythritol, j is 3, R₉ is hydrogen and d is 0.

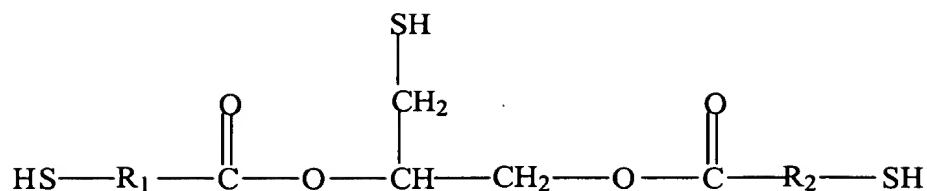
10 70. The photochromic article of claim 57 wherein said second monomer has allyl groups and is represented by the following general formula:



wherein R is a radical derived from a polyol, R₁₀ is a radical derived from an allyl or substituted allyl group and i is a whole number from 2 to 6.

15 71. The photochromic article of claim 70 wherein the polyol from which R is derived is 4,4'-isopropylidenediphenol, i is 2, and R₁₀ is a radical derived from an allyl group.

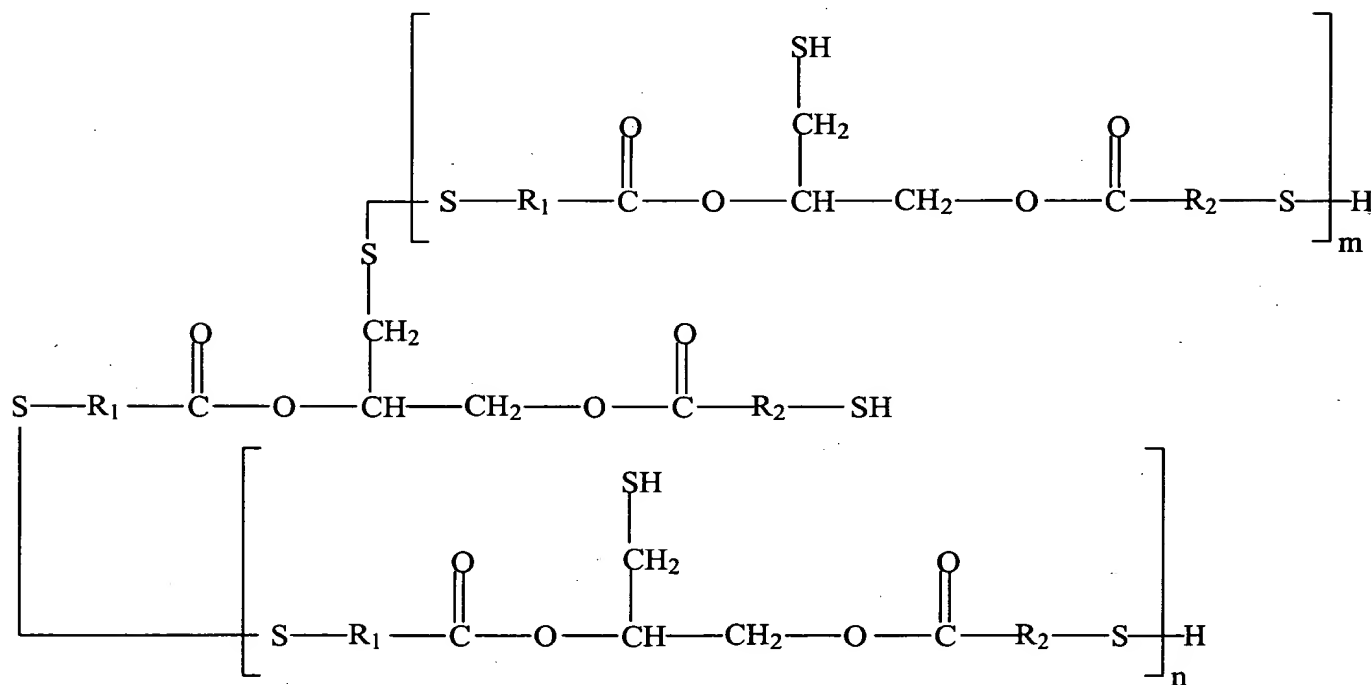
20 72. The photochromic article of claim 57 wherein said polythiol monomer is one or more selected from the group consisting of 2,5-dimercaptomethyl-1,4-dithiane, 2,2'-thiodiethanethiol, pentaerythritol tetrakis(3-mercaptopropionate), pentaerythritol tetrakis(2-mercaptoacetate), trimethylolpropane tris(3-mercaptopropionate), trimethylolpropane tris(2-mercaptoacetate), 4-mercaptomethyl-3,6-dithia-1,8-
25 octanedithiol, 4-tert-butyl-1,2-benzenedithiol, 4,4'-thiodibenzenethiol, benzenedithiol, ethylene glycol di(2-mercaptoacetate), ethylene glycol di(3-mercaptopropionate), poly(ethylene glycol) di(2-mercaptoacetate), poly(ethylene glycol) di(3-mercaptopropionate), a polythiol represented by the following general formula:



in which R_1 and R_2 are each independently selected from the group consisting of straight or branched chain alkylene, cyclic alkylene, phenylene and $\text{C}_1 - \text{C}_9$ alkyl substituted phenylene, and oligomers of said polythiols.

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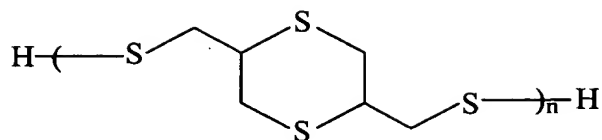
73. The method of claim 72 wherein said polythiol oligomer is represented by the general formula:



wherein R_1 and R_2 are each independently selected from straight or branched chain alkylene, cyclic alkylene, phenylene and $\text{C}_1 - \text{C}_9$ alkyl substituted phenylene and n and m are independently integers from 0 to 21 such that $n + m$ is at least 1.

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74. The polymerizable organic composition of claim 72 wherein said polythiol oligomer is represented by the general formula:



wherein n is an integer from 1 to 21.

75. The photochromic article composition of claim 57 wherein said monoethylenically unsaturated monomer is one or more selected from the group consisting of styrene, methyl methacrylate, isobornyl methacrylate, phenoxyethyl methacrylate, cyclohexyl methacrylate, vinyl acetate, vinyl chloride, mercaptoethyl (meth)acrylate, vinyl mercaptan and allyl mercaptan.

76. The photochromic article of claim 57 wherein said anhydride monomer is selected from the group consisting of methacrylic anhydride, acrylic anhydride, maleic anhydride, 1-cyclopentene-1,2-dicarboxylic anhydride, itaconic anhydride and mixtures of said monomers.

77. The photochromic article of claim 56 having an initial Barcol hardness of at least 1, a refractive index of from about 1.57 to about 1.80 and an Abbe number of at least about 30.

78. The photochromic article of claim 56 further comprising additives selected from the group consisting of light stabilizers, heat stabilizers, antioxidants, ultraviolet light absorbers, mold release agents, static (non-photochromic) dyes, pigments and flexibilizing additives and anti-yellowing additives; and mixtures of said additives.

79. The photochromic article of claim 78 wherein the additives are present in an amount up to 10% by weight of said polymerizate.

80. The photochromic article of claim 56 wherein the polymerized polymerizable organic composition further comprises a photochromic substance.

81. The photochromic article of claim 80 wherein the photochromic substance is applied to the surface of the polymerized polymerizable organic composition.

82. The photochromic article of claim 80 wherein the photochromic substance is applied to the polymerized polymerizable organic composition at from 0.15 to 0.35 milligrams per square centimeter of surface area of said photochromic article.

83. The photochromic article of claim 80 wherein said photochromic substance is selected from the group consisting of spiro(indoline)naphthoxazines, spiro(indoline)benzoxazines, chromenes, benzopyrans, naphthopyrans, organo-metal dithizonates, (aryloxy)-thioformic arylhydrazidates, mercury dithizonates, fulgides, fulgimides, 3-furyl fulgides, 3-thienyl fulgides, 3-furyl fulgimides and 3-thienyl fulgimide; and mixtures of said photochromic substances.

84. The photochromic article of claim 80 wherein the photochromic substance has an activated absorption maximum within the visible range of from 590 to 700 nanometers.

85. The photochromic article of claim 80 wherein the photochromic substance has an activated absorption maximum within the visible range of from 400 to 500 nanometers.

86. The photochromic article of claim 80 wherein the photochromic substance has an activated absorption maximum within the visible range of from 500 to 700 nanometers.

87. The photochromic article of claim 80 wherein the photochromic substance is applied or incorporated into said photochromic article using a method selected from the list consisting of dissolving within the polymerizate, dispersing within the polymerizate, encapsulating within a matrix of an organic polymerizate and incorporating into the polymerizable organic composition prior to curing.

88. The photochromic article of claim 80 wherein the photochromic substance is applied by imbibing the photochromic article such that permeation of the photochromic substance into the polymerizate is achieved.

5 89. The photochromic article of claim 88 wherein the imbibing process includes solvent assisted transfer absorption.

90. The photochromic article of claim 88 wherein the imbibing process includes vapor phase transfer.

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91. The photochromic article of claim 80 wherein the photochromic substance is applied as a coating to the surface of the photochromic article.

92. The photochromic article of claim 88 wherein the imbibing process
15 includes the steps of:

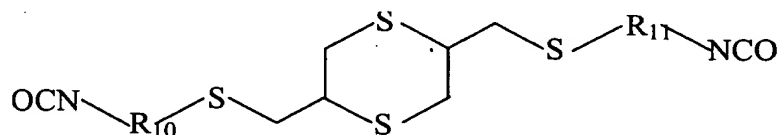
coating the photochromic article with the photochromic substance;
heating the surface of the photochromic article; and
removing the residual coating from the surface of the photochromic article.

20 93. The photochromic article of claim 80 wherein the photochromic article is an optical lens for correcting a visual defect.

94. The polymerizate of claim 27 wherein the polycyanate monomer having at least two functional groups has one or more sulfur atoms in its backbone.

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95. The polymerizate of claim 94 wherein the polycyanate monomer containing one or more sulfur atoms in its backbone has the general structure:

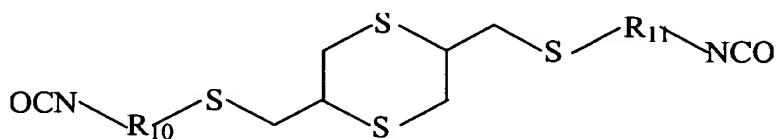


wherein R_{10} and R_{11} are each independently C_1 to C_3 alkyl.

96. The photochromic article of claim 58 wherein the polycyanate monomer having at least two functional groups has one or more sulfur atoms in its backbone.

5

97. The photochromic article of claim 96 wherein the polycyanate monomer containing one or more sulfur atoms in its backbone has the general structure:



wherein R_{10} and R_{11} are each independently C_1 to C_3 alkyl.

10